

## Northeast Salmon Team Fact Sheet Collection

# The Postsmolt Trawl Survey Program

Atlantic salmon have a complex life history, spending 1-3 years in freshwater and then undertaking a strenuous migration into the marine environment. They spend an additional 1-3 years at sea before returning to their natal rivers to spawn. Although Atlantic salmon face many challenges (both natural and anthropogenic during their freshwater residency), their migration to and from the ocean and time at sea are particularly taxing.

Dramatic physiological changes take place before smolts are able to transition from freshwater into the saline marine environment. During this transition period, smolts also encounter unfamiliar environmental conditions and a new complex of predators including seals, waterbirds, and other fish. Smolts that successfully navigate these obstacles must then contend with the challenges associated with inhabiting a marine environment as postsmolts.

In the marine environment, salmon not only encounter a new suite of predators, but are also at the mercy of large scale oceanographic processes. For example, climate changes shape the physical, chemical, and biological conditions of the sea which in turn influence marine ecology (e.g. foodweb structure). Declining return rates of Atlantic salmon worldwide suggest that the conditions Atlantic salmon are exposed to at sea effect marine survival and growth; however, the mechanisms by which these conditions influence salmon in this respect are not well understood.

NEST researchers are particularly interested in learning more about Atlantic salmon and the conditions they encounter as they transition into the marine environment. Globally, this is a much-understudied part of Atlantic salmon ecology, partially because of the expense and logistical complications associated with operating at sea.



*With camouflage markings along its sides, the parr life stage of an Atlantic salmon (above) is adapted for river life. After spending two years in freshwater, parr transform into smolts (below) and become adapted for life at sea. During this transformation, smolts become physiologically capable of excreting salt and also take on a more silvery, streamlined form typical of marine pelagic fishes. From the time they leave their natal river as smolts to when they return as adults to spawn, Atlantic salmon face numerous challenges, many of which are not well understood.*

In 2001, NEST initiated the Penobscot Bay Postsmolt Trawl Survey (PST) as a sampling platform to address Atlantic salmon issues specific to Maine's Penobscot River and Bay. With the PST, NEST researchers hope to understand the factors that influence Atlantic salmon migration, distribution, and survival at sea.

Although the PST is thus far limited to the Penobscot system, NEST researchers hope that what is learned from the PST will have broader applicability to Atlantic salmon and sampling programs elsewhere. Furthermore, by improving its pelagic sampling techniques, NEST will be more prepared for an international marine survey program organized by NASCO which is slated to begin in 2008 and aimed at understanding bigger picture issues such as marine survival.

A major component of the PST is collecting information on hatchery reared postsmolts to improve our understanding of smolt and postsmolt movement and the contribution of stocked individuals to the population. To do this, NEST (in cooperation with Green Lake National Fish Hatchery, GLNFH) carries out an extensive smolt mark-stock-recapture study on the Penobscot River that extends into the bay.

A portion of the parr representing the lower size-range of the smolt population at GLNFH are administered fin clips and stocked in the fall prior to the spring stocking of their larger counterparts. It is believed that fall stocked parr will remain in the river and emigrate in the second spring after release. Likewise, a portion of the smolts that are stocked in the spring are marked with fin clips and/or tags (e.g. VIE or PIT tags).

Some of the marked individuals stocked into the Penobscot River are recaptured further downstream (in rotary screw traps) and in the Greater Penobscot Bay (with the PST). These recaptures enable researchers to gain information related to the effects of stocking date and location on smolt emigration and allow for the evaluation of different restoration stocking strategies.

Wild-spawned and hatchery-produced fry (stocked every spring to coincide with the natural emergence of wild-spawned fry from redds) also contribute to the Penobscot population and are caught in rotary screw traps and the PST. Sampling these naturally reared fish enables researchers to evaluate the impact of the natural rearing conditions on growth and mortality. However, because stocked fry are not administered a distinguishing mark or clip, it is not possible to distinguish them from wild spawned individuals at this time.



Above, a hatchery reared smolt from GLNFH is marked with a Visual Implant Elastomer tag (VIE). VIE tags are specific to stocking date and site.

rotary screw traps



postsmolt trawl





The Postsmolt Survey Trawl was conducted from 2001-2005 during the smolt emigration period (late spring). A pelagic net was pair-trawled by two vessels at the surface and throughout the Greater Penobscot Bay. An aluminum “aquarium” at the net’s codend allowed captured fish to safely swim in a non-turbulent pool of water until the trawl was retrieved. All tows were conducted for 30 minutes except for the offshore tows which were conducted for one hour.



*The aquarium is hoisted on board the trawling vessel after a 30 minute tow.*

**General Sampling:** All postsmolts were counted and the following information collected:

- length (mm) & weight (g)
- fin condition/deformities (can help determine origin)
- degree of smoltification (based on external characteristics)
- marks (e.g. fin clips) and tags (e.g. VIE)

Priority for further biological sampling was given to postsmolts with certain tags and/or fin clips, as well as those presumed to be of naturally reared origin.

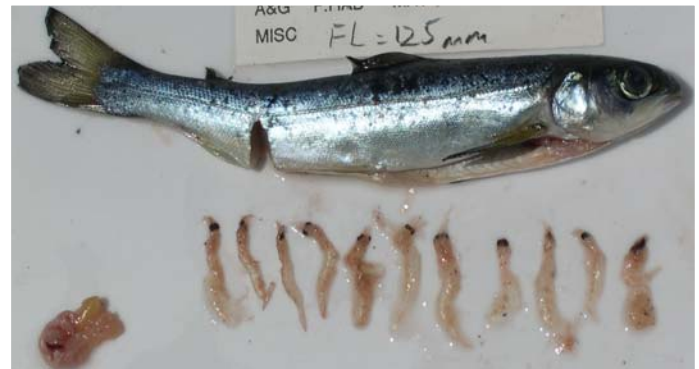
**Scale and genetic samples:** taken for age and origin (hatchery or naturally reared) determination.

**Gill and blood samples:** collected to assess postsmolt physiological condition. Additional gill samples were collected from postsmolts identified by tag as being treated under the ongoing Marical SeaReady™ project. Data generated from these samples are being used to determine if fish undergoing the treatment demonstrate a physiological advantage over untreated (control) fish.

**Muscle tissue samples:** collected from certain marked fish for a new RNA:DNA study that seeks to provide an alternative way to measure growth from the time of stocking to capture in the PST.

**Stomachs:** extracted from postsmolts that perished due to trawling or sampling (~5% of the total annual catch). Stomach content data is being used to investigate dietary habitats of postsmolts.

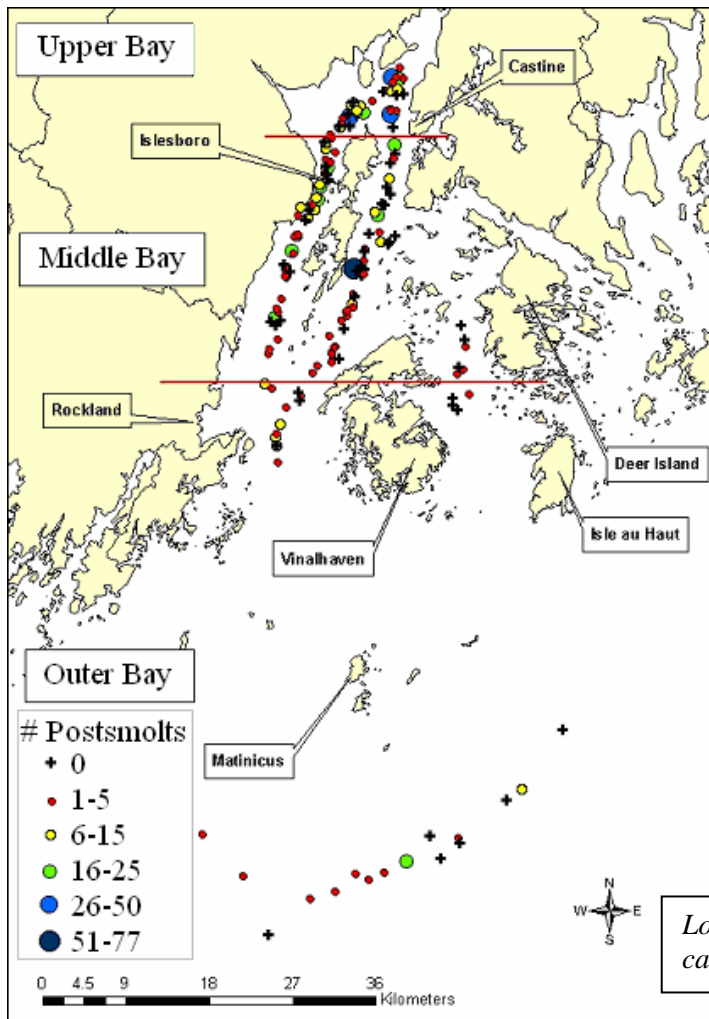
**Non-target species:** All non-target species captured were identified, counted, measured and weighed. Species that occupy the same space as out-migrating Atlantic salmon provide a unique ecological dataset that improves our understanding of species interactions.



*Stomach samples tell us that postsmolts feed on a variety of prey items, including krill (above) and juvenile herrings (below).*



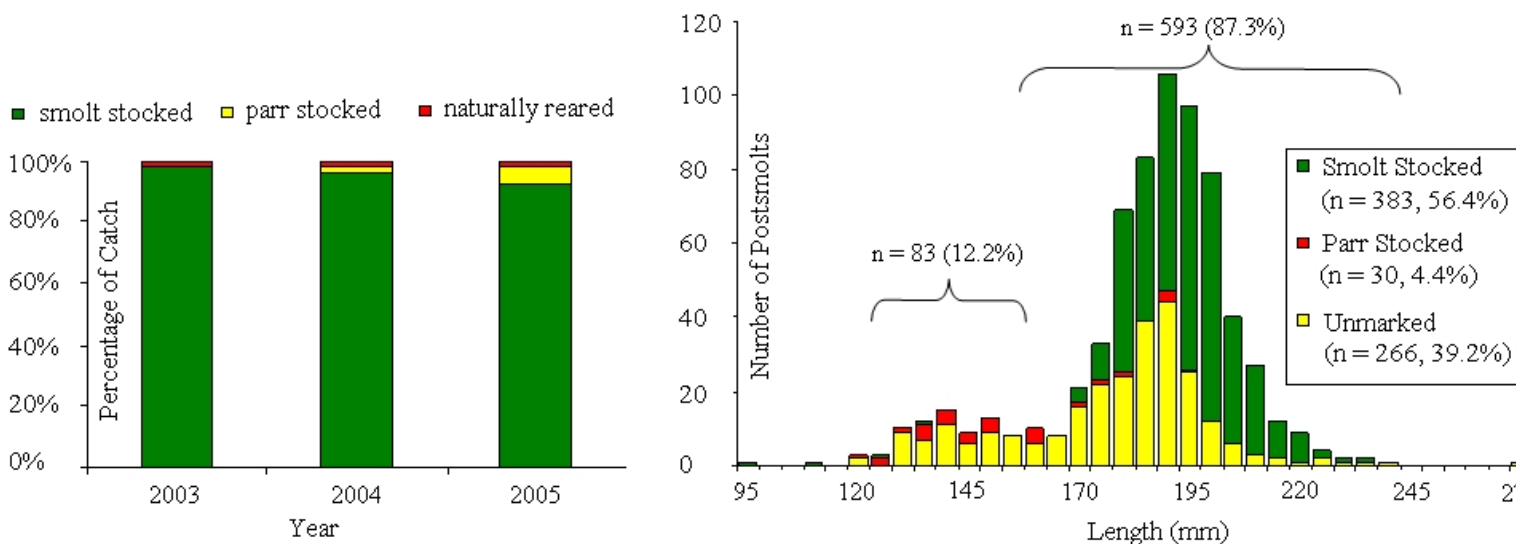
*Non-target species captured in a tow.*



Since 2001, the PST has captured and sampled approximately 3,400 postsmolts

- Over 1,000 postsmolts with VIE tags or fin clips have provided valuable information related to different stocking strategies.
- General sampling has allowed NEST researchers to better understand the contribution of hatchery and naturally reared individuals to the postsmolt population.
- Approximately 1,600 scales have been collected and are currently being used to assist NEST researchers in verifying the origin of sampled individuals.
- The 1,000 physiological samples that have been collected since the PST's inception are currently being analyzed

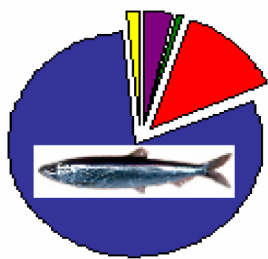
Location of tows and number of postsmolts caught during the PST in 2005.



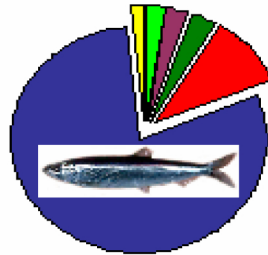
**Left graph:** Analysis of origin-related data (e.g. observed hatchery-administered marks, scales, fish length/weight, and dorsal fin condition) from the 2003-2005 PST reveals that the overwhelming majority of the postsmolts caught during the trawl were stocked as smolts.

**Right graph:** A length-frequency distribution of the postsmolts caught during the 2005 PST reveals a bimodal distribution. Fall stocked parr tend to occur in the lower mode (120-160 mm) and individuals stocked as smolts tend to dominate the upper mode (160-220 mm). The presence of a bi-modal length distribution may afford NEST another means by which to identify unknown origin fish (i.e. individuals falling within the lower mode as stocked parr and those in the upper mode as stocked smolts). These results suggest that parr stocked individuals may make up a larger proportion of the total catch than previously thought. Studies are currently underway to explore this issue further.





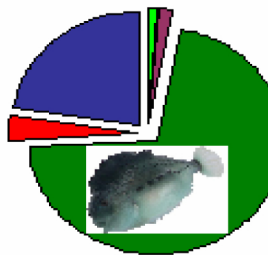
Upper Bay



Middle Bay



Inner Outer Bay

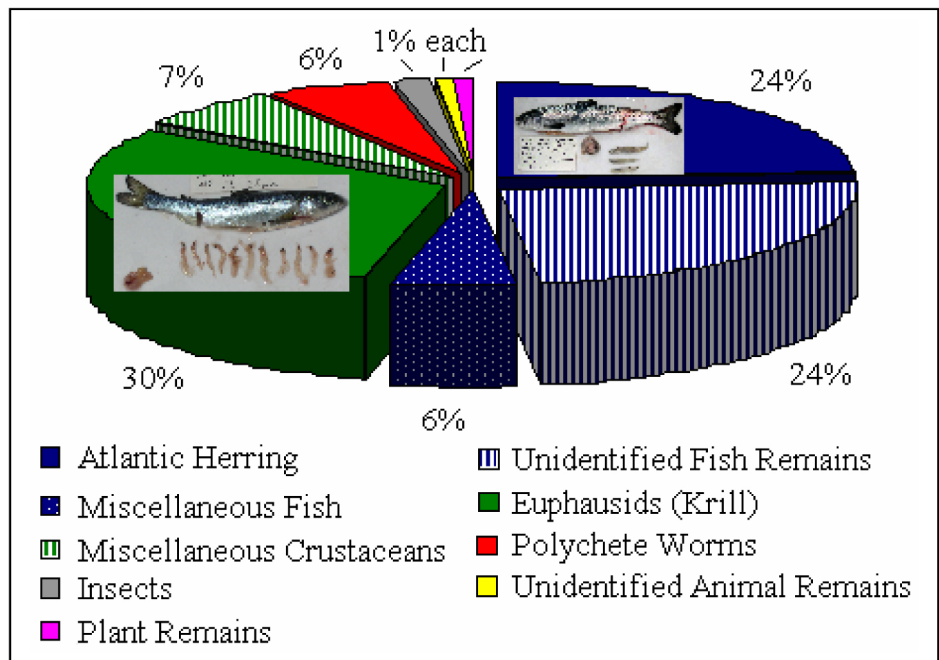


Outer Outer Bay

■ Atlantic Mackerel  
■ Alewife  
■ Blueback Herring

■ Atlantic Herring  
■ Lumpfish  
■ Other

*Non-target species composition (by weight) of PST tows from 2003 – 2005 reveals that Atlantic herring are the dominant species in the Upper and Middle Bay Areas, and lumpfish are the dominant fish species in the offshore Outer Bay Areas. Other species include American shad, striped bass, sea lamprey, rainbow smelt, Atlantic tomcod, capelin, Atlantic silversides, threespined stickleback, hake species, and butterfish.*



*The contents of the stomachs extracted from Atlantic salmon postsmolts captured from 2001-2005 reveal that Atlantic herring and krill are the major prey items of Atlantic salmon in Penobscot Bay. Unidentified fish remains are most likely those of Atlantic herring, whereas miscellaneous fish include wrymouth, rock gunnel, radiated shanny, searaven and sculpin species. Miscellaneous crustaceans include amphipods, copepods and isopods.*

Data collected during the PST are used to guide future sampling efforts and to help scientists and managers better understand the factors influencing Penobscot River Atlantic salmon dynamics.

Although there is no simple answer to why adult Atlantic salmon return rates continue to decline, PST data may help to contribute to a better understanding of postsmolt ecology and current restoration stocking strategies. The PST continues to be part of a larger, ongoing NEST endeavor to improve understanding related to Atlantic salmon, especially during the critical time at which they transition from freshwater into marine environments.

The Northeast Salmon Team (NEST) operates within the Northeast Region of NOAA Fisheries Service to promote the recovery and future sustainability of Atlantic salmon. We are composed of fisheries managers and scientists jointly based out of the Orono, Maine Field Station; scientists based out of the Woods Hole, Massachusetts Northeast Fisheries Science Center (NEFSC) and Narragansett, Rhode Island Laboratory; and managers based out of the Gloucester, Massachusetts Northeast Regional Office (NERO). Please visit our website at <http://www.nefsc.noaa.gov/salmon/>

